

REMARKS

The Office Action dated May 21, 2003, has been received and carefully noted. The following remarks, are submitted as a full and complete response thereto. Claims 1-18 are respectfully submitted for consideration.

Claims 1-4 were rejected under 35 U.S.C. § 103(a) as being unpatentable over Uchikawa et al. (European Patent Application No. 0319031, "Uchikawa") in view of Matsumura et al. (European Patent Application No. 0463543A1, "Matsumura"). Uchikawa was cited for disclosing many of the claimed elements of the invention with the exception of the OH content and feed rate. Matsumura was cited for curing this deficiency. Claims 4-13 depend from claims 1-3. The Applicants traverse the rejection and respectfully submit that claims 1-4 recite subject matter that is neither disclosed nor suggested by the cited prior art.

Claim 1 recites a quartz glass crucible for pulling up a silicon single crystal, comprising a crucible base body constituted of a semi-transparent quartz glass layer and a transparent quartz glass layer formed on an inner wall surface of the crucible base body. No expanded bubbles equal to or more than 0.5 mm in diameter are present in a layer 1 mm in depth from an inner surface of the quartz glass crucible after the silicon single crystal is pulled up using the quartz glass crucible. With an arc rotation melting method, the base body is prepared in a mold using silicon dioxide powder and an inner layer is formed on an inner surface of the base body using silicon dioxide powder under conditions that the silicon dioxide powder has a gas content equal to or less than 30 $\mu\text{l/g}$ and an OH group concentration equal to or less than 300 ppm. A heat melting power is applied in the range of 400 to 1000 kw. A horizontal distance

from an arc center to a falling position of the silicon dioxide powder is in the range of 50 to 300 mm. A distance from the arc center to an inner surface of piled-up powder on a bottom of the base body is equal to or less than 800 mm. A particle diameter of the silicon dioxide powder is equal to or less than 300 μm . A feed rate of the silicon dioxide powder is equal to or less than 200 g/min.

Claim 2 recites a quartz glass crucible for pulling up a silicon single crystal, comprising a crucible body constituted of a semi-transparent quartz glass layer and a transparent quartz glass layer formed on an inner wall surface of the crucible base body. No expanded bubbles equal to or more than 0.5 mm in diameter are present in a layer 1 mm in depth from an inner surface of the quartz glass crucible after the silicon single crystal is pulled up using the quartz glass crucible. With an arc rotation melting method, the base body is prepared in a mold using silicon dioxide powder and an inner layer is formed on an inner surface of the base body using silicon dioxide powder under conditions that the silicon dioxide powder has a gas content equal to or less than 20 $\mu\text{l/g}$ and an OH group concentration equal to or less than 300 ppm. A heat melting power is applied in the range of 200 to 400 kw. A horizontal distance from an arc center to a falling position of the silicon dioxide powder is in the range of 50 to 300 mm. A distance from the arc center to an inner surface of piled-up powder on a bottom of the base body is equal to or less than 800 mm. A particle diameter of the silicon dioxide powder is equal to or less than 300 μm . A feed rate of the silicon dioxide powder is equal to or less than 200 g/min.

Claim 3 recites a quartz glass crucible for pulling up a silicon single crystal, comprising a crucible body constituted of a semi-transparent quartz glass layer and a

transparent quartz glass layer formed on an inner wall surface of the crucible base body. No expanded bubbles equal to or more than 0.5 mm in diameter are present in a layer 1 mm in depth from an inner surface of the quartz glass crucible after the silicon single crystal is pulled up using the quartz glass crucible. With an arc rotation melting method, the base body is prepared in a mold using silicon dioxide powder and an inner layer is formed on an inner surface of the base body using silicon dioxide powder under conditions that the silicon dioxide powder has a gas content equal to or less than 30 $\mu\text{l/g}$ and an OH group concentration equal to or less than 300 ppm. A heat melting power is applied in the range of 600 to 2000 kw. A horizontal distance from an arc center to a falling position of the silicon dioxide powder is in the range of 50 to 300 mm. A distance from the arc center to an inner surface of piled-up powder on a bottom of the base body is equal to or less than 1500 mm. A particle diameter of the silicon dioxide powder is equal to or less than 300 μm . A feed rate of the silicon dioxide powder is equal to or less than 200 g/min.

Applicants discovered a new quartz glass crucible as a result of paying attention to the bubbles of the quartz glass crucible after pulling up the silicon single crystal. As a consequence, the claimed invention recites the effective ranges of conditions for the prevention against bubble expansion of a quartz glass crucible after pulling up the silicon single crystal. Thus, the claimed invention is new in the art. The Applicants submit that the prior art fails to disclose or suggest the claimed invention, and therefore, fails to provide the critical and non-obvious advantages that are provided by the invention.

Uchikawa discloses a quartz glass crucible that is used in the process of pulling a single crystal semiconductor material.

Matsumura discloses a quartz glass crucible that is used in the manufacture of a silicon single crystal.

With respect to claims 1-4, the Applicants respectfully submit that the combination of Uchikawa and Matsumura fails to disclose or suggest the claimed features of the invention. Claims 1-3 each recite an OH group concentration equal to or less than 300 ppm, and a horizontal distance from an arc center to a falling position of the silicon dioxide powder in the range of 50 to 300 mm. Claim 1 additionally recites that the silicon dioxide powder has a gas content equal to or less than 30 $\mu\text{l/g}$, a heat-melting power applied in the range of 400 to 1000 kw, and a distance from the arc center to an inner surface of piled-up powder on a bottom of the space body being equal to or less than 800 mm. Claim 2 additionally recites that the silicon dioxide powder has a gas content equal to or less than 20 $\mu\text{l/g}$, a heat-melting power applied in the range of 200 to 400 kw, and a distance from the arc center to an inner surface of piled-up powder on a bottom of the space body being equal to or less than 800 mm. Claim 3 additionally recites that the silicon dioxide powder has a gas content equal to or less than 30 $\mu\text{l/g}$, a heat-melting power applied in the range of 600 to 2000 kw, and a distance from the arc center to an inner surface of piled-up powder on a bottom of the space body being equal to or less than 1500 mm.

As acknowledged in the Office Action Uchikawa fails to disclose the claimed OH content and feed rate. The Applicants further submit that Uchikawa also does not disclose a horizontal distance from an arc center to a falling position of the silicon

dioxide powder, and in particular, that the horizontal distance is in the range of 50 to 300 mm, as recited in claims 1-3.

Also, Uchikawa does not disclose the gas content of silicon dioxide powder, and in particular a gas content of equal to or less than 30 $\mu\text{l/g}$, as recited in claims 1 and 3, and a gas content of equal to or less than 20 $\mu\text{l/g}$, as recited in claim 2. Further, Uchikawa also does not disclose or suggest a heat melting power, and in particular, a heat melting power in the ranges of 400 to 1000 kw as recited in claim 1, 200 to 400 kw as recited in claim 2, and 600 to 2000 kw as recited in claim 3. Furthermore, Uchikawa does not disclose a distance from the arc center to an inner surface of piled-up powder on a bottom of the base body, and in particular, the claimed distance of equal to or less than 800 mm, as recited in claims 1 and 2, or equal to or less than 1500 mm as recited in claim 3. Therefore, Uchikawa fails to disclose additional features of the invention recited in claims 1-3.

The Applicants further submit that Matsumura fails to cure the deficiencies in Uchikawa with respect to claims 1-3, as Matsumura does not disclose or suggest the gas content of silicon dioxide powder, nor does the reference disclose or suggest the range of the heat melting power, the range of the horizontal distance from an arc center to a falling position of the silicon dioxide powder, and the distance from the arc center to an inner surface of a piled-up powder on a bottom of the base body, as recited in claims 1-3. Therefore, Matsumura fails to cure the significant deficiencies in Uchikawa with respect to claims 1-3. As such, the combination of Uchikawa and Matsumura does not disclose or suggest each and every feature of the invention as recited in claims 1-4.

Claims 5-18 were rejected under 35 U.S.C. § 103(a) as being unpatentable over Uchikawa in view of Matsumura and Sato et al. (U.S. Patent No. 5,989,021, "Sato"). Uchikawa and Matsumura were cited for disclosing many of the claimed elements of the invention with the exception of the diameter of the crucible in the range of 22 to 28 inches and in the range of 30 to 48 inches. Sato was cited for curing this deficiency. Claims 5-13 depend from claims 1-3 and claims 17 and 18 depend from claims 14-16. The Applicants traverse the rejection and respectfully submit that claims 5-18 recite subject matter that is neither disclosed nor suggested by the cited prior art.

Claim 14 recites a production method for a quartz glass crucible for pulling up a silicon single crystal, the quartz glass crucible having a diameter in the range of 22 to 28 inches. With an arc rotation melting method, a base body is prepared in a mold using silicon dioxide powder and an inner layer is formed on an inner surface of the base body using silicon dioxide powder under conditions that the silicon dioxide powder has a gas content equal to or less than 30 $\mu\text{l/g}$ and an OH group concentration equal to or less than 300 ppm. A heat melting power is applied in the range of 400 to 1000 kw. A horizontal distance from an arc center to a falling position of the silicon dioxide powder is in the range of 50 to 300 mm. A distance from the arc center to an inner surface of piled-up powder on a bottom of the base body is equal to or less than 800 mm. A particle diameter of the silicon dioxide powder is equal to or less than 300 μm . A feed rate of the silicon dioxide powder is equal to or less than 200 g/min.

Claim 15 recites a production method for a quartz glass crucible for pulling up a silicon single crystal, the quartz glass crucible having a diameter in the range of 22 to 28 inches. With an arc rotation melting method, a base body is prepared in a mold using

silicon dioxide powder and an inner layer is formed on an inner surface of the base body using silicon dioxide powder under conditions that the silicon dioxide powder has a gas content equal to or less than 20 $\mu\text{l/g}$ and an OH group concentration equal to or less than 300 ppm. A heat melting power is applied in the range of 200 to 400 kw. A horizontal distance from an arc center to a falling position of the silicon dioxide powder is in the range of 50 to 300 mm. A distance from the arc center to an inner surface of piled-up powder on a bottom of the base body is equal to or less than 800 mm. A particle diameter of the silicon dioxide powder is equal to or less than 300 μm . A feed rate of the silicon dioxide powder is equal to or less than 200 g/min.

Claim 16 recites a production method for a quartz glass crucible for pulling up a silicon single crystal, the quartz glass crucible having a diameter in the range of 30 to 48 inches. With an arc rotation melting method, a base body is prepared in a mold using silicon dioxide powder and an inner layer is formed on an inner surface of the base body using silicon dioxide powder under conditions that the silicon dioxide powder has a gas content equal to or less than 30 $\mu\text{l/g}$ and an OH group concentration equal to or less than 300 ppm. A heat melting power is applied in the range of 600 to 2000 kw. A horizontal distance from an arc center to a falling position of the silicon dioxide powder is in the range of 50 to 300 mm. A distance from the arc center to an inner surface of piled-up powder on a bottom of the base body is equal to or less than 1500 mm. A particle diameter of the silicon dioxide powder is equal to or less than 300 μm . A feed rate of the silicon dioxide powder is equal to or less than 200 g/min.

Sato discloses a quartz crucible with an inner diameter of 22 inches or more.

With respect to claims 5-18, the Applicants respectfully submit that Uchikawa, Matsumura and Sato, either singly or in combination, do not support a *prima facie* case of obviousness for purposes of rejecting claims 5-18 under 35 U.S.C. §103. The PTO has the burden under §103 to establish a *prima facie* case of obviousness. In re Fine, 5 USPQ2d 1596, 1598 (Fed. Cir. 1988). Both the case law of the Federal Circuit and the PTO itself have made clear that where a modification must be made to the prior art to reject or invalidate a claim under §103, there must be a showing of proper motivation to do so. The mere fact that a prior art reference could arguably be modified to meet the claim is insufficient to establish obviousness. The PTO can satisfy this burden only by showing some objective teaching in the prior art or that knowledge generally available to one of ordinary skill in the art would lead that individual to combine the relevant teachings of the references. Id. In order to establish obviousness, there must be a suggestion or motivation in the reference to do so. See also In re Gordon, 221 USPQ 1125, 1127 (Fed. Cir. 1984) (prior art could not be turned upside down without motivation to do so); In re Rouffet, 149 F.3d 1350 (Fed. Cir. 1998); In re Dembiczak, 175 F.3d 994 (Fed. Cir. 1999); In re Lee, 277 F.3d 1338 (Fed. Cir. 2002).

Claims 5, 14, and 15 recite a crucible having a diameter in the range of 22 to 28 inches, and claim 16 recites a crucible having a diameter in the range of 30 to 48 inches. As acknowledged in the Office Action, Uchikawa and Matsumura fail to disclose or suggest these features. Specifically, Uchikawa discloses the production of a quartz crucible of 14 inches in diameter. The Office Action took the position that it would have been obvious to modify the diameter of the crucible of Uchikawa from 14 inches to either the range of 22 to 28 or the range of 30 to 48 inches in order to create a large

diameter crucible. This is an insufficient showing of motivation as the Office Action has not indicated how the references themselves, or the prior art in general provide support for the suggested modification to Uchikawa. Further, the Examiner's motivation for modifying Uchikawa with the teachings of Sato, in order to arrive at the claimed invention, appears to have been derived from the Applicant's disclosure, which is the improper application of hindsight.

Furthermore, the combination of Uchikawa, Matsumura and Sato does not disclose or suggest each and every feature of the invention as recited in claims 14-16. As acknowledged in the Office Action, Uchikawa fails to disclose the claimed OH content and feed rate. As discussed above, with respect to claims 1-3, the Applicants further submit that Uchikawa also does not disclose a horizontal distance from an arc center to a falling position of the silicon dioxide powder, and in particular, that the horizontal distance is in the range of 50 to 300 mm, as recited in claims 14-16. Uchikawa also does not disclose the gas content of silicon dioxide powder, and in particular a gas content of equal to or less than 30 $\mu\text{l/g}$, as recited in claims 14 and 16, and a gas content of equal to or less than 20 $\mu\text{l/g}$, as recited in claim 15. Further, Uchikawa does not disclose or suggest a heat melting power, and in particular, a heat melting power in the ranges of 400 to 1000 kw as recited in claim 14, 200 to 400 kw as recited in claim 15, and 600 to 2000 kw as recited in claim 16. Furthermore, Uchikawa does not disclose a distance from the arc center to an inner surface of piled-up powder on a bottom of the base body, and in particular, the claimed distance of equal to or less than 800 mm, as recited in claims 14 and 15, or equal to or less than 1500 mm as recited in claim 16. As discussed above, Matsumura fails to cure these deficiencies.

Sato fails also to cure these deficiencies as Sato does not disclose a gas content, a heat melting power, a horizontal distance from an arc center to a falling position of the silicon dioxide powder, and a distance from the arc center to an inner surface of piled-up powder on a bottom of the base body. Therefore, the combination of Uchikawa, Matsumura and Sato fails to disclose each and every feature of the invention as recited in claims 14-16.

The Office Action stated that it would have been obvious to modify Uchikawa by combining Uchikawa with Matsumura with respect to claims 1-4, and combining Uchikawa, Matsumura and Sato with respect to claims 5-18 to accomplish the advantages of the present invention, or to accomplish general advantages not specifically identified within the references. See, e.g., Office Action at page 3. With respect to claims 1-4, the Applicants submit that Uchikawa and Matsumura either singly or in combination fail to disclose or suggest each and every feature of the invention as recited in claims 1-4. With respect to claims 5-18, the Office Action has not provided a sufficient showing of motivation for the combination of Uchikawa, Matsumura and Sato, or the modification of Uchikawa. Further, Uchikawa, Matsumura and Sato either singly or in combination fails to disclose or suggest each and every feature of the invention as recited in claims 14-16. Therefore, the Applicants respectfully submit that the Office Action has failed to establish a *prima facie* case of obviousness for purposes of a rejection of claims 1-18 under 35 U.S.C. §103.


Claims 1-18 are pending. Claims 4-13 depend from claim 1-3, and claims 17 and 18 depend from claims 14-16. The Applicants respectfully submit that claims 4-13, 17 and 18 are allowable for their dependency from allowable base claims 1-3 and 14-16 as

well as the additional subject matter recited therein. As discussed above, the combinations of Uchikawa, Matsumura and Sato, fail to disclose or suggest the claimed features of the invention. Accordingly, the Applicants respectfully request allowance of claims 1-18 and the prompt issuance of a Notice of Allowability.

Should the Examiner believe anything further is desirable in order to place this application in better condition for allowance, the Examiner is requested to contact the undersigned at the telephone number listed below.

In the event this paper is not considered to be timely filed, the Applicants respectfully petition for an appropriate extension of time. Any fees for such an extension, together with any additional fees that may be due with respect to this paper, may be charged to counsel's Deposit Account No. 01-2300, **referencing Attorney Docket No.: 107242-09013.**

Respectfully submitted,



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